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Two sided display device

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## Two sided display device

The invention relates to a two-sided display device and a mobile phone comprising such two-sided display device.

A two-sided display device is a device having at least two display surfaces, a first display surface for viewing on a first side and a second display surface for viewing on a second side. Such two-sided display devices are known as such and are used in for example mobile phones. For example, JP2000-058260 display a two-sided organic electroluminescent display device wherein a metal cathode is provided on each side with organic electroluminescent material and a transparent ITO anode. This device has a disadvantage in that its manufacture is not compatible with conventional methods of manufacturing organic electroluminescent devices. Conventionally, organic electroluminescent devices are manufactured by successive deposition of layers. Because of its reactivity the metal cathode is conventionally formed at a final stage of manufacture. If the device of JP2000-058260 is manufactured in a conventionally manner the metal cathode layer cannot be deposited at a final stage. Also, having a central cathode layer the displays formed on either side have the same size. For many applications this is unnecessary or even undesirable.

It is an object of the invention, inter alia, to provide a two-sided display which does not have the above-mentioned disadvantage and is capable of being manufactured using conventional manufacturing methods. Moreover, the two-sided display should be thin and well-protected from outside influences such as dust, moisture and the like.

These and other objects are achieved by means of a two-sided display device comprising a first display having a first display surface, a second display having a second display surface, a first substrate light-transmissive for light emitted by the first display, a second substrate light-transmissive for light emitted by the second display and fastening means fastening the first substrate to the second substrate wherein the first and second substrate are arranged parallel and spaced to one another, the first display device is, with the first display surface facing the first substrate, provided on a side of the first substrate facing the second substrate providing the two-sided display with a first viewing side and the second

display device is, with the second display surface facing the second substrate, provided on a side of the second substrate facing the first substrate providing the two-sided display device with a second viewing side opposite the first.

5 The two-sided display in accordance with the invention has two separate displays which each may be manufactured in a conventional manner. Moreover, having two separate displays operation of each display may proceed independent of the other and use of different displays, in size and/or type is easily accomplished. Since the two displays are spatially separated from one another, risk of cross-talk is reduced if not eliminated. By providing the first and second electroluminescent on facing sides of individual first substrates  
10 a thin, compact and robust arrangement is obtained. The first substrate serves to protect the second electroluminescent device whereas the second substrate serves to protect the first electroluminescent device. No separate protective plates are necessary.

In a preferred embodiment of the two-sided display device in accordance with the invention the first and/or second electroluminescent device is an organic, low molecular  
15 or polymer, electroluminescent device.

Providing the facing sides of the first and/or the second substrates with electroluminescent displays is of particular advantage if organic or more particular polymer electroluminescent devices are used. In order to operate properly, such devices need protection from moisture and/or oxygen. To provide such protection, an organic  
20 electroluminescent device is commonly enclosed in an air and moisture proof housing. Such a housing is typically formed of a substrate, onto the device is provided, and a cover which, by means of a perimeter seal, is attached to the substrate. In the two-sided display in accordance with the invention, the first substrate serves as cover for the second and vice versa. Thus only a single perimeter seal is required to enclose two electroluminescent  
25 displays which results in a thin construction because the seal line add substantially to the overall thickness.

In a particular embodiment of the two-side display in accordance with the invention, the fastening means is a perimeter seal providing, in co-operation with the first and second substrate, a closed housing for the first and second display device.

30 The first and second substrate may be fastened using any suitable fastening means such as clamps, rivets, tape bolts or adhesive such as glue. A preferred fastening means is a perimeter seal which connects the first and second substrate and completely surrounds both the first and second (electroluminescent) display. The perimeter seal provides

a closed housing preventing ingress of unwanted contaminants such as dust, moisture and/or oxygen.

Preferably the perimeter seal is formed of organic adhesive material such as epoxy adhesive. Alternatively, a gasket may be used which by means of glue or other means is secured, air and/or moisture proof, to the first and second substrate. If the two-sided display comprises one or more organic electroluminescent devices a getter may be used which getters any oxygen and/or moisture that may enter the housing via the perimeter seal.

The substrate, first and second, may be formed of any (composite) material, glass and synthetic resin being preferred materials, provided the part facing the display area is light transmissive for the light emitted by the display. If the display device is air and/or moisture sensitive the synthetic resin is preferably combined with one or more barrier layers impervious to moisture and/or oxygen. Such substrates are known as such.

In a preferred embodiment of the two-sided display device in accordance with the invention the first and/or second substrate is an integral part of the first and/or the second display respectively.

Most types of displays, liquid crystal display and organic electroluminescent displays being examples, include one or more substrates as an integral part of the display. A particular compact arrangement is obtained if such a substrate is used as the first or the second substrate.

Having two separate displays allows the possibility of using two different displays. In a particular embodiment of the two-sided display in accordance with the invention, the first display is a stand-by display and the second display is a display-on-demand display. The stand-by display which is on most of the time may be a display of low resolution and low power whereas the display-on-demand may be high resolution and high power, the combination providing a good balance with the quality of display and power consumption.

The invention may be used for any application in which displays are used. A preferred application is a mobile phone or any other device including mobile phone functionality.

These and other aspects of the invention will be apparent from and elucidated with reference to the drawings and the embodiments described hereinafter.

In the drawings:

Fig. 1 shows, schematically, in a plan view, a mobile phone comprising a two-sided display; and

Fig. 2 shows, schematically, in a cross-sectional view, a two-sided display in accordance with the invention.

5

Fig. 1 shows, schematically, in a plan view, a mobile phone 1. The phone 1 has a keypad member 3 and a display member 5 connected via a hinge 4 to the keypad member 3. The display member 5 has a two-sided display 7 providing a viewing side to both sides of the display member 5, one primarily for use when the phone is open, the other to be  
10 used when the phone is closed.

Fig. 2 shows, schematically, in a cross-sectional view, a two-sided display in accordance with the invention.

The two-sided display 7 comprises a first display 9 having a first display surface 11 and a second display 13 having a second display surface 15.

15 The first and/or second display may be of any type such as a liquid crystal display, in particular a single-substrate LCD, an electro-phoretic display, an electro-wetting display, an electroluminescent display or even a plasma display. Preferably, the display 9 and/or 13 is an organic, low molecular or polymeric, electroluminescent display. Such displays are thin and can be manufactured using a single substrate. Moreover, since organic  
20 electroluminescent displays are particularly sensitive to oxygen and moisture the protection offered by the substrates 17 and 19 is of particular advantage. The first display 9 and similarly the second display 13 may be a single pixel display merely providing an indicator or signage function or a multi-pixel display capable of displaying images such as text, graphics video. The image on display may be a fixed image or a variable image on input of  
25 image data provided by driving circuitry (not shown). The first or second display may be a segmented, optionally time-multiplexed, or a matrix, active or passive, display. The first and second displays 9 and 13 may be monochrome, multi-color or full-color displays. The driving circuitry may be hard-wired to provide the same image information to each display or the driving circuitry may be wired to allow different images to be displayed on the first and  
30 second display at any time. The first and second display may be of a same or different type, size and/or display technology. For many applications, such a mobile phone, it may suffice to combine a simple inexpensive low-resolution display with a more complex, expensive high-resolution display. For example, an indicator or fixed image display which is continuously driven in stand-by mode may be combined with a (full-color) matrix display which displays

only on demand. Not necessarily, but typically, the first and second displays of the two-sided display 7 are themselves one-sided displays. In Fig. 2 the first display is one-sided display having a display surface 11 and the second display 13 is a one-sided display having display surface 15. Each display surface may have any shape, mutually the same or different.

5           The two-sided display has a first substrate 17 onto which the first display 9 is provided. The first substrate 17 serves to support, position and protect the displays from external influences such as mechanical forces exerted on the display, dust, and other contaminants such as air and moisture and furthermore provides mechanical integrity to the two-sided display. In order to allow light emitted by the first display 9 to leave the two-sided display 7 at least (a part of) the region of the first substrate 17 opposite the display surface 11 is to be light transmissive for such emitted light. The second substrate 19 provides functionality similar to that provided by the first substrate 17 to that by the second display 13. Only the region opposite the display surface 11, 15 respectively may have such light transmission properties or the entire substrate may have such properties.

15           The first and second substrate may be identical or different. Materials which may be used to form the first and second substrates include metal, ceramics, textile wood, and glass. Synthetic resin may also be used. Glass and synthetic resin are preferred. In particular if the two-sided display comprises organic electroluminescent displays moisture and/or air proof substrates are required. Substrates including metal or glass sheets are useful in this respect. In case of a synthetic resin based substrate, one or more barrier layer impervious to air and/or oxygen need to be included to effectively protect the display devices. Such substrates are known in the art as such.

20           The substrates 17 and 19 typically have a thickness in a range from about 50  $\mu\text{m}$  to about 2 cm, more particular 100 to about 1 mm. The substrates may be flexible or rigid.

25           The substrates 17 and 19 are arranged parallel and spaced to one another. In order to fasten the substrate 17 and 19 to one another fastening means 21 are employed. In principle any fastening means may be used. For example a clamps, rivets or nut and bolt means may be used. The substrates may also be glued together. To keep the first and second substrate at a fixed separation, spacers may be used such as spheres or rods having a desired diameter. A gasket which runs around the first and second display may also be used, such an arrangement also referred to as a perimeter seal. In co-operation with the first and second substrate the gasket provides a closed housing for the first and second display and hence an enhanced protection against the ingress of dust, moisture and air. If the gasket is formed of

resilient material mechanical shock protection is also improved. Adhesive layers provided between the gasket and the substrates may be used to further seal the two-sided display. As an alternative to a gasket an adhesive perimeter seal may be used such as a seal of epoxy adhesive such seals being known in the art for sealing housings for electroluminescent devices.

If the closed housing as such provides insufficient protection against ingress of water and/or air to the extent that such ingress degrades the first and/or second display such as would be the case if an adhesive epoxy perimeter seal is used to seal a housing for an organic electroluminescent device, a getter 23 adapted to getter such moisture and/or air (oxygen) may be used. Suitable getter for this purpose is BaO.

In addition or alternatively the displays 9 and 13 may themselves be encapsulated by means of a barrier layer impervious to air and/or moisture.

The first display device 9 is provided on a side of the first substrate 17 facing the second substrate 19 such that the first display surface 11 faces the first substrate 17.

Similarly, the second display 13 is provided on a side of the second substrate 19 facing the first substrate 17 such that the second display surface 15 faces the second substrate 19. In operation, the first display 9 provides a first viewing side and the second display 13 a second viewing side opposite the first.

The displays being arranged on facing sides of the first and second substrates results in a two-sided display which is particularly thin and robust because the first substrate is part of the housing for the second display and vice versa. Only a single perimeter seal is required. Such shared use of substrates results in a thinner display.

Displays which can be suitably used in the two-sided display in accordance with the invention typically comprise one or more substrates. For example, an organic electroluminescent display typically comprises one substrate onto which a first electrode layer, an electroluminescent layer and a second electrode layer is provided. A conventional LCD typically has two substrates. Such display may simply be provided on the first or second substrate of the two-sided display. However, further integration and thus thinner two-sided displays are obtained if the substrate 17 and/or 19 is an integral part of the display 9 and/or 13 respectively.



## CLAIMS:

1. A two-sided display device comprising a first display having a first display surface, a second display having a second display surface, a first substrate light-transmissive for light emitted by the first display, a second substrate light-transmissive for light emitted by the second display and fastening means fastening the first substrate to the second substrate  
5 wherein the first and second substrate are arranged parallel and spaced to one another, the first display device is, with the first display surface facing the first substrate, provided on a side of the first substrate facing the second substrate providing the two-sided display with a first viewing side and the second display device is, with the second display surface facing the second substrate, provided on a side of the second substrate facing the first substrate  
10 providing the two-sided display device with a second viewing side opposite the first.
2. A two-sided display device as claimed in claim 1 wherein the first and/or second electroluminescent device is an organic, low molecular or polymer, electroluminescent device.  
15
3. A two-sided display device as claimed in claim 1 or 2 wherein the fastening means is a perimeter seal providing, in co-operation with the first and second substrate, a closed housing for the first and second display device.
- 20 4. A two-sided display device as claimed in claim 3 wherein the perimeter seal is formed of organic adhesive material and, optionally, comprises a getter for gettering oxygen and/or water arranged within the closed housing.
5. A two-sided display device as claimed in claim 1, 2, 3 or 4 wherein the first  
25 and/or second substrate comprises a sheet of glass or, in combination with one or more barrier layers impervious to water and/or oxygen, synthetic resin.
6. A two-sided display device as claimed in claim 1, 2, 3, 4 or 5, wherein the first and/or second substrate is an integral part of the first and/or the second display respectively.

7. A two-sided display device as claimed in claim 1, 2, 3, 4, 5 or 6, wherein the first display is a stand-by display and the second display is a display-on-demand display.

5 8. A mobile phone having a two-sided display device as claimed in any one of the claims 1 to 7.

**ABSTRACT:**

A two-sided display device has, spaced and parallel to one another, a first and a second substrate. The facing sides of the substrates are each provided with a display which has a display surface facing the substrate onto which it is provided. The substrates are fastened to one another by means of, for example, a perimeter seal providing a closed housing for the display devices. The substrates protect the display devices against ingress of dust, moisture and the like. The second substrate assists in protecting the first display and the first substrate assists in protecting the second display thus providing a well-protected and thin two-sided display device.

10 Fig. 2

1/1

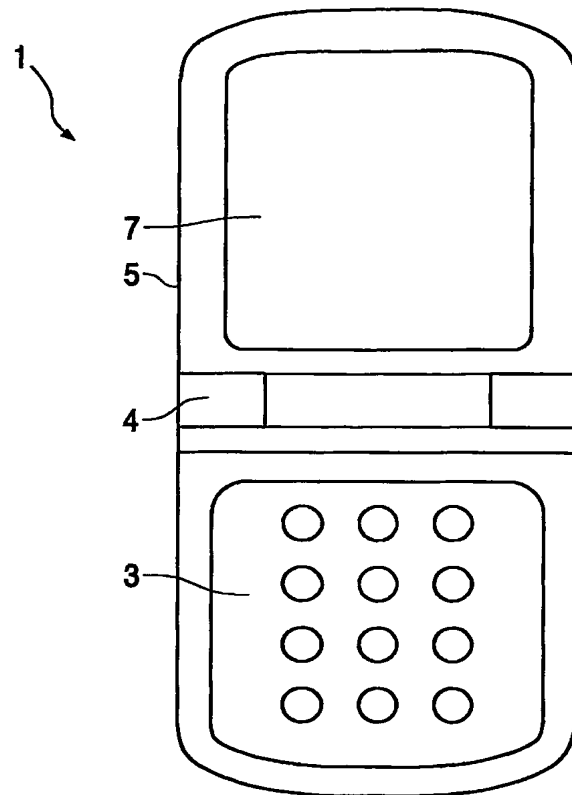


FIG. 1

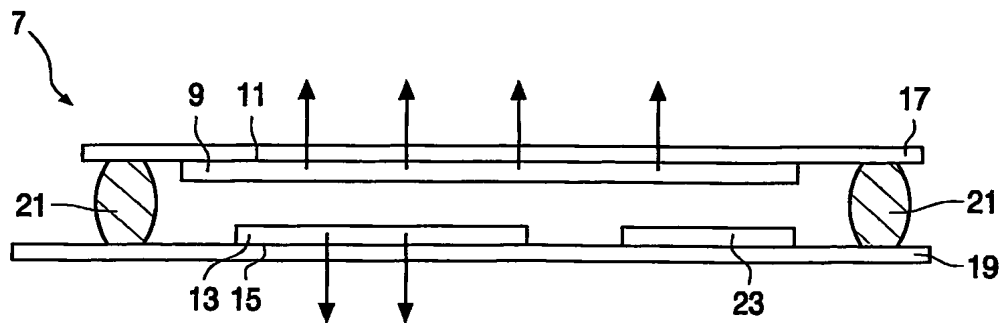


FIG. 2

**PCT/IB2004/050402**

